DOCUMENT RESUME

ED 325 403 SE 051 744

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TITLE Teacher Qualifications and Secondary Mathematics Instruction: Retraining and Recruitment Needs in San Diego, California.
PUB DATE 1 Jan 85
NOTE 12p.
PUB TYPE Reports - Evaluative/Feasibility (142)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Classroom Observation Techniques; Computers; *Inservice Teacher Education; Interviews; Mathematics Education; *Misassignment of Teachers; Preservice Teacher Education; *Problem Solving; Program Descriptions; Surveys; Teacher Characteristics; *Teacher Qualifications; *Teacher Recruitment; Teacher Transfer; *Teaching Experience; Teaching Skills
IDENTIFIERS *California Mathematics Project

ABSTRACT

This report summarizes the activities of the California Mathematics Project established in 1983 using survey data, classroom observations, and interviews. The central goal of this program was to provide leadership in improving the quality of mathematics instruction throughout the state of California. Information was collected for use in planning re-training programs for secondary mathematics teachers. The survey results indicate that a proportion of teachers are new-to-mathematics instruction, teach mathematics on a part-time basis, and have transferred to their current position from non-mathematics departments within the same district. Problems with problem solving, the lack of computer integration, responses to student needs, modeling, student motivation, socio-economic level, teaching schedules, class size, teaching style, and job satisfaction are identified from class observations and interviews. Recommendations are included. (KR)

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TEACHER QUALIFICATIONS AND SECONDARY MATHEMATICS INSTRUCTION: RETRAINING AND RECRUITMENT NEEDS IN SAN DIEGO, CALIFORNIA

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1 Janauary 1985

This report summarizes the activities of the joint UCSD and SDSU California Mathematics Project (Grant #UCSD 5052), directed by Alfred Manaster and Randall Souviney at the University of California, San Diego, and Douglas McLeod at San Diego State University.

SE051744

ACKNOWLEDGEMENTS

The authors wish to acknowledge the contributions of the San Diego State University, California Mathematics Project Faculty and Participants, the District Personnel Directors who made special efforts to assist with the current Project, and Hugh Mehan and James Levin who reviewed the final report upon which this summary is based. Without their generous support and cooperation, it would have been impossible for us to complete this ambitious undertaking.

Teacher Qualifications and Secondary Mathematics Instruction: Retraining and Recruitment Needs In San Diego, California

Several national reports published in recent years have made wide-ranging recommendations for improving the quality of our schools. Each recommends increasing the quality and quantity of mathematics required of all secondary school graduates. In San Diego and Imperial Counties, high schools now require between two and three years of mathematics of their graduating seniors. This represents almost a doubling of the minimum mathematics requirements over the last two years. The minimum mathematics requirement for university entrance has increased by one additional year as well.

While these requirements have been increasing, the availability of qualified secondary mathematics teachers has been decreasing. Our surveys indicated that only about 34% of the secondary mathematics teacher appointments made during the past six years have been filled by individuals possessing appropriate credentials and adequate mathematics background. The distribution of credentials and appointment types among new-to-mathematics teachers showed that over 70% of these appointments were teachers already in the system. They transferred from other disciplines and were most in need of upgrading in mathematics.

The California Mathematics Project (CMP) was established in 1983 by the California Legislature with the mandate to provide leadership in improving the quality of mathematics instruction throughout the State. The central goal of the University jof California, San Diego/San Diego State University CMP Project was to collect information useful in planning re-training programs for secondary mathematics teachers in San Diego and Imperial Counties. A District Personnel Survey and an individual Teacher Survey were conducted to obtain background information on mathematics teachers' preparedness and experience. The returns on each survey yielded data for approximately 56% of the area's secondary mathematics teachers. Comparisons with the California Basic Education Data System (CBEDS), which collects data on all California teachers yearly, indicated that the UCSD Surveys were reasonably representative of the population of secondary mathematics teachers in the two counties.

Survey Results

In San Diego and Imperial Counties, approximately 60% of the mathematics

teachers have full-time mathematics teaching assignments. Half of all secondary mathematics teachers have less than 10 years mathematics teaching experience. The most frequently reported level of mathematics teaching experience was 1-3 years. Finally, approximately 47% of all mathematics instructors teach at least one section of a college-preparatory course (basic algebra and higher level courses). These figures together indicate that a significant proportion of teachers are new-to-mathematics instruction, teach mathematics on a part-time basis and have transferred to their current position from non-mathematics departments within the same district. Many of these teachers are responsible for college-preparatory as well as general and career mathematics courses.

The academic mathematics backgrounds of teachers is considered a critical factor for the quality of secondary mathematics programs. The National Council of Teachers of Mathematics recommends that Junior High mathematics teachers possess a minimum of an academic Minor in mathematics and at the Senior High level, a minimum of a mathematics Major. The UCSD District Survey showed that 44% of all grade 7-12 mathematics teachers are listed by their districts as having less than a college Minor in mathematics, while the results of the UCSD Teacher Survey showed only 20% reporting less than a Minor. This discrepancy may be accounted for in two ways: (1) District Personnel offices often do not maintain an accurate record of academic Minors and (2) some teachers may have reported "informal" Minors based on mathematics courses taken since graduation. Both Surveys indicated that about 36% of all secondary mathematics teachers have a mathematics Major and more than 5% have earned a Master's degree in mathematics.

We estimate that total of about one-third of the approximately 1265

teachers in San Diego and Imperial Counties may need to upgrade their mathematics knowledge. Since many of these teachers with limited formal mathematics backgrounds may have acquired expertise from teaching mathematics over the course of many years, their numbers could be subtracted from this total in arriving at an estimate of the number of teachers in need of immediate re-training. Of those mathematics teachers appointed in the last six years, we estimate that about 250 currently require mathematics content and instructional methods upgrading. Our results indicate that nearly 13% of these new-to-mathematics teachers who reported less than a Minor in mathematics are responsible for one or more sections of college-preparatory mathematics. Overall, about 5% of the teachers responsible for one or more sections of a college-preparatory course have less than a Minor in mathematics.

Among the plans available to teachers for improving and upgrading mathematics skills are the CMP Summer Institute, courses at local colleges, universities, and TEC Center, and three district-administered re-training programs organized in conjunction with community colleges. Two of the district programs lead to local certificates; only one is approved by the California Commission on Teacher Credentialing to recommend for issuance of Supplementary Introductory Mathematics authorizations. Approximately 90 teachers will be participating in these programs in San Diego County during 1984-85. It is estimated that a two-year program of study leading to an academic Minor and a Supplementary Authorization to an existing credential could reasonably be mounted by local Universities and School Districts to accommodate up to 100 teachers per year. Such a program could provide for the effective upgrading of these new-to-mathematics teachers in time to do some good.

Plans to offer continuing education for teachers already fully qualified to teach secondary mathematics include the CMP Summer Institute and the district level Mentor Teacher Program. An extended year appointment plan for qualified mathematics teachers should be considered as a way to more fully utilize existing talents in the areas of program development, inservice leadership, research, and teaching.

Classroom Observations

In addition to survey data, observations and interviews were conducted during the 1983 CMP Summer Institute with participants and throughout the year with a small number of participants. A summary of conclusions made from this corpus of data is listed below.

Problem-solving will be a curriculum focus in school mathematics during the 1980's. Problem-solving activities have a powerful appeal to teachers of all levels of experience and background, but those with less mathematics teaching experience and academic background find it somewhat harder to integrate the activities into the standard curriculum. If problem-solving is to become an effective component within the mathematics curriculum, it will need to be incorporated into the standard instructional materials teachers use.

The use of small, mixed-ability groupings for problem-solving and other mathematics activities is being encouraged by mathematics educators. This innovation was less likely to be maintained as an instruction component by teachers than other new instruction strategies. Reportedly, this was due to

fact that the social re-structuring tended to result in off-task behavior on the part of students. Large classes, which were the rule, also presented difficulties for the successful introduction of small-group activities.

Computers were not integrated into mathematics instruction. Administrators and teachers tend to regard computers as a separate content domain and, in general, believe that mathematics teachers must learn how to teach programming before they can effectively use the technology in their teaching. Recent research indicates this not to be the case. Another problem preventing effective instructional applications of computers was the lack of emphasis during the Institute on methods for structuring the use of one machine for 35 students. However, as a result of the Institute, the participants seemed to embrace the wide-scale use of calculators within the mathematics curriculum.

Other new materials and activities introduced to teachers during the summer tended to be used at the beginning of the year, then to drop off in use, and finally to be re-introduced on a less frequent basis in the Spring. More experienced mathematics teachers of all backgrounds were more flexible in the use of new materials and in improvising upon standard text materials.

The likelihood that new materials introduced in training programs would be integrated into classroom instruction seemed more a function of how much time was spent using the new materials during training, rather than the inherent interest in or innovative nature of the materials. Most summer participants felt that a methods course organized around the grade-level taught rather than around the participants' backgrounds would have been useful. This has been arranged for the 1984 summer program.

Responding to student needs was regarded by the participants as an important component in effective teaching. At the Junior High level, teachers must often rearrange large lesson segments to accommodate the wide range of student achievement. Since teachers with less advanced mathematics backgrounds are often assigned to these introductory courses, their training should include a focus on flexibility within lesson presentations. All teachers were seen to be flexible in adapting lessons in response to feedback from students. However, the effectiveness of these shifts in lesson organization was positively related to the number of years teaching mathematics.

The most prevalent classroom instructional technique is modelling of appropriate responses by the teacher, including inferential thinking. Emphasis in teacher education should be placed on methods for encouraging more active participation of students in both teacher-directed and small group lessons.

Student motivation, socio-economic level, teaching schedules, and class size all interact with teaching style and the way a teacher views their teaching. Class size and range of students' abilities particularly affect the performance of new-to-mathematics teachers.

The tendency of all teachers to fall into routines, both desirable and undesirable, is strong. If change in practice is warranted and desired by the teacher, these practices may be mitigated by the systematic presence of professionally supportive observers in the classroom; by having the teachers reflect on their own practices on a regular basis; and by frequent

professional contacts with colleagues.

Non-traditional measures of change in students and teachers, though reasonably easy to recognize, are somewhat harder to specify objectively. Teachers tend to judge their effectiveness by relying on feedback from colleagues and by a "sense" of having communicated well during a lesson. Until alternative criteria can be objectively specified, test results and teacher intuition will continue to be the most prevalent form of student evaluation.

Developing professionalism among teachers is vital to the health of school mathematics programs. The CMP Institute contributed greatly in this regard by providing collegial contact throughout the year and by regarding the participants' feedback as vital to its success. Leadership activities, although indirectly promoted during the 1983 session, were a direct outcome of the Institute. An extended leadership emphasis has been planned for the 1984 SDSU CMP Institute.

Job satisfaction does not seem to depend on having access to progressive instructional models, although a feeling of professionalism may. Job satisfaction depends on factors like control in the classroom, effectiveness as an instructor, the feeling of being a resource for colleagues, and monetary reward. More emphasis during training should be placed on issues of classroom management. More resources should be allocated by schools and districts for participation in professional activities. Uncertainty about scheduling and class assignments is detrimental to teacher dedication, especially for those teachers undergoing a change in teaching assignment and subsequent upgrading of content knowledge.

The San Diego community is effectively working towards a support network for improved mathematics instruction through inter-segmental cooperation. Training and dialogue for and among experienced and non-experienced secondary teachers is a significant activity promoted by the CMP Institute. Parent involvement is also being encouraged at the school level, in part, through the use of the Mathematics Diagnostic Testing Program instruments (jointly developed by the University of California and the California State University, these criteria-referenced tests are reported to be predictive of potential achievement in Algebra 2, Trigonometry and Calculus).

Recommendations

The following recommendations were made:

1. The California Mathematics Project should consider encouraging local CMP Projects to become directly involved in the re-training of new-to-mathematics teachers who have limited formal training in mathematics. The San Diego State University CMP Institute (1983-84) can serve as a model in this regard.

2. Inter-segmental cooperation within the education community can significantly increase the efficiency of retraining programs. Universities, County Departments of Education, Teacher Education and Computer Centers (TECC) and local Districts should cooperate in the development of re-training programs which lead to at least an academic Minor in mathematics and California Commission for Teacher Credentialling (CTC) Supplementary Authorization to existing credentials.

3. The California Mathematics Project should encourage local Projects to identify highly qualified secondary mathematics teachers for leadership training. These teachers should participate actively in the upgrading of content and methods knowledge for new-to-mathematics colleagues. CMP Internships and cooperation with existing Mentor Teacher Programs should be explored as possible alternatives.

4. The California Basic Education Data System (CBEDS) teacher questionnaire should be expanded to include questions which will provide more detailed information on teachers' academic backgrounds and the type of credential authorization used for their current teaching appointment.

For more information on this study, contact Randall Souviney, Teacher Education Program D-002, University of California, San Diego, La Jolla, California 92093.

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Date Filmed

March 29, 1991